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Research Paper

Vulnerability of Infrastructures of the Department of Public Works and Highways of Region 02 Philippines to Climate Change

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ABSTRACT: *Infrastructures contribute significantly to national development; however, the world's changing environment has become a major threat to infrastructure resiliency. It is for this reason that this study was conducted to determine the extent of vulnerability of the infrastructures of the Department of Public Works and Highways (DPWH) to climate change with respect to exposure, sensitivity, and adaptive capacity. The descriptive research design was used in the study and the survey questionnaire is the main data gathering tool being used to elicit information from 116 participants. This study found out that there is a moderate extent of vulnerability of existing roads, drainages, and bridges along the national primary road networks of Region 02. The overall result of the study implies that DPWH Region 02 is working its share on climate change adaptation; however, barriers need to be addressed. It is therefore recommended that DPWH management should enhance its overall adaptive capacity and that technical professionals should continue to support programs and policies on climate change adaptation by enhancing their awareness, knowledge, and expertise.*
KEYWORDS: *Climate Change Adaptation, Knowledge and Awareness, Disaster Response Program, Barriers, Vulnerability*

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I. INTRODUCTION

Infrastructures play a vital role in national development. It forms the backbone of the society – serving as the foundation for the economic, social and cultural life of communities and countries [1]. Infrastructure brings development to business, industry and trade that are significant to economic growth, stability, and achievement of globalized development goals. On the other side, lack of infrastructures poses significant limitations to economic development and social well-being. It has been proven that for a developing country to succeed in economic endeavor, infrastructure investment must be a priority.

The Philippine spending for infrastructure has grown significantly over the past years as an answer of the government to major weakness on investment climate. For 2016, the infrastructure program comprised 5 percent of the country's gross domestic product that covers major transportation facilities both in urban and rural areas. Economic growth is expected to soar as a result of infrastructure investment; however, world changing environmental condition has become a major threat to infrastructure resiliency. The effects of climate change have become adverse on essential infrastructures.

According to the study of the Philippine Atmospheric Geophysical and Astronomical Services Administration [2], all areas of the Philippines will get warmer, more so in the relatively warmer summer months. Annual mean temperatures in all areas in the country are expected to rise by 0.9 degree Celsius to 1.1 degrees Celsius in 2020 and by 1.80 degrees Celsius to 2.2 degrees Celsius in 2050. Projections for extreme events in 2020 and 2050 show that hot temperatures will continue to become frequent, number of dry days will increase, and heavy daily rainfall events will also continue to increase in number in Luzon and Visayas. An average of 20 typhoons will visit the county yearly that challenges the performance of physical infrastructures as a result of changes in temperature, extreme rainfall, typhoon frequency and sea levels.

The study of Hilario [3] as cited by Peñalba, et al. [4] revealed that the intensity of typhoons is getting stronger, especially since the 1990s, as a result of the analysis of 59-year data on tropical cyclones in the

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Philippines. Based on statistics, destructive typhoons like Ondoy, Yolanda, and Lawin left more than 584.82 billion pesos of damages to infrastructures, agriculture, and physical assets.

In the Philippines' Region 02, there are about four out of eight cyclones that made a landfall in 2008, leaving behind billions of pesos in damages to properties [5]. The typhoons particularly affected low-lying barangays in municipalities traversed by the Cagayan River. There are about 52 municipalities, 1.85 million hectares of flood prone areas and 650,243 hectares of alluvial plains in Cagayan, Isabela and Nueva Vizcaya that are at risk. In a study conducted by WWF-Philippines and BPI Foundation, they claim that the increasingly deforested hillsides of the three mountain ranges where Cagayan River drains water will certainly reduce their capacity for water absorption. This will fuel increase run-off, leading to the greater probability of floods. The study of Yusuf and Francisco [6] revealed that Cagayan Valley is one of the areas in the Philippines with the highest vulnerability. This is due to the exposure of the region not only to tropical cyclones but also due to many other climate-related hazards especially floods, landslides due to terrain, and drought. Similarly, the National Economic and Development authority (NEDA) and National Disaster Coordinating Council (NDCC) in 2010 mentioned that Cagayan is one of the most vulnerable places in the Philippines in terms of economy and its ability to cope up with natural calamities due to climate change [7].

With the noted climate change effects and impact, infrastructure facilities are threatened as they are directly exposed to climate stressors. It is expected that a 100-year flood might be reduced to a 50-year flood under a future climate change scenario. High temperatures will affect road conditions that may lead to delays. Excessive precipitation will induce landslides closing major thoroughfares. Flooding may breach water infrastructures like river protection and flood control structures, overtop highways and bridges and challenge the capacity of existing drainage systems. Stronger typhoons will surely bring disruption of other facilities. By affecting the "normal" range of environmental conditions and the frequency and severity of extremes, climate change poses a potential threat to these systems – from degrading their integrity and performance [8].

Resilient and reliable infrastructure is essential for the society. Yet the risks posed to infrastructure by a changing climate are often not fully considered as these systems are not planned, designed, and constructed [1]. With this, there is a high need to develop adaptation strategies and measures to sustain existing infrastructure and construct resilient ones.

Adaptation to climate change is defined as initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effect [9]. Though crucial, adaptation can greatly reduce adverse effects and realize opportunities associated with climate change [10]. Without adaptation, economic losses could be expected and thus, will result to a net cost in the future, and these costs will grow overtime [11].

In the Philippines, the Philippine Climate Change Framework has been set up to take into account how climate change impact and vulnerabilities shall be addressed by adaptation, mitigation and cross-cutting strategies which would eventually lead to achievement of national development goals. One of the strategic policies includes the institutionalized guidelines for the construction of innovative climate-resilient and energy efficient infrastructure systems; however, less have been known about vulnerabilities of specific structures to climate change, the performance of climate change adaptation and the factors affecting it. Vulnerability and adaptation assessments need to be generated to serve as the country's scientific basis towards quantifying and prioritizing climate-related vulnerabilities and refining adaptation strategies in both national and local settings (National Framework Strategy on Climate Change, 2010- 2022). In the local setting, the Department of Interior and Local Government (DILG) has issued the Memorandum Circular (MC) No. 2014-135 to clarify the roles and responsibilities of Local Government Units (LGUs): to deliver their mandate as provided for under Republic Act (RA) 9729 (as amended by RA 10174); to provide guidelines on the steps and processes in the formulation of Local Climate Change Action Plan (LCCAP); and, to inform the process of mainstreaming and integration of DRR and CCA in local mandated plans.

With these premises, this study seeks to determine the determine the extent of vulnerability of the infrastructures of the Department of Public Works and Highways (DPWH) to climate change with respect to exposure, sensitivity, and adaptive capacity.

Identifying the level of awareness and knowledge of technical professionals on climate change adaptation is essential to establish a ground of work volume and limitation. Outputs reflect the perceivable problems. Also, an evaluation of the current practices in designing infrastructure adaptable to climate change is a vital tread to carry out the acceptable and desirable approach to such adaptation. A standard review on the efficiency of disaster response and implementation measures and strategies is significant in the developmental assessment to shape policy and regulation. If managed correctly, investment in infrastructure adaptation will create quality performance to install, upgrade and maintain the new resilient infrastructure. Moreover, barriers in the adoption of climate change adaptation strategies as well as the existing condition and level of vulnerability of infrastructures to climate change must be identified to offset a realistic view of the future resolution and reliability of infrastructure-based services, and to plan accordingly.

Statement of the Problem

This study sought to determine the extent of vulnerability of the infrastructures to climate change of DPWH Region 02, Philippines.

Specifically, it endeavored to answer the following questions:

1. What is the profile of infrastructures in Region 2, Philippines in terms of:
   1.1. Type of Infrastructures, and
   1.2. Years of existence?
2. What is the degree of vulnerability of infrastructures to climate change?
   2.1 Exposure;
   2.2 Sensitivity; and
   2.3 Adaptive Capacity?
3. Is there a significant difference in the degree of vulnerability of infrastructures to climate change when grouped according to types of infrastructures?
4. What proposed activities can be implemented to enhance the climate change adaptation of DPWH Region 02 Philippines?

II. METHODS

Research Design

The research design that was used in the study is the descriptive research design since it attempted to determine the climate change adaptation of DPWH Region 02.

Research Participants

The participants of the study consisted of 116 technical professionals of the DPWH Region 02. The number included the design engineers and maintenance engineers who have permanent position in the district engineering offices (DEO) and the regional office (RO).

Table 1
Number of Research Participants

Research Participants	Regional Office	District Engineering Office	Total
Design Engineers	10	53	63
Maintenance Engineers	7	46	53
Total	17	99	116

Data Gathering Instruments

The researchers made used of the survey questionnaire as the main data gathering tool in generating the needed information from the participants. The survey questionnaire underwent try-out and validation procedures to ensure its content validity and reliability before it is finally administered to the research participants. There were three (3) sets of questionnaires being used. Set A was used to generate information from design engineers. The questionnaire has four (4) parts: Part I elicited personal and professional data from the participants; Set B was used to generate information from maintenance engineers. The questionnaire has four (4) parts: Part I elicited personal and professional data from the participants; Set C was used to generate information from the district chief maintenance engineers and maintenance engineers regarding the degree of vulnerability of existing infrastructures. Unstructured interviews were conducted to clarify the data gathered by the questionnaire.

The questionnaires were formulated by the researchers. Some of its content were lifted from the DPWH Design Guidelines, Criteria and Standards 2015 Edition and the Department Order (DO) No. 15, series 2015, “Guidelines to Ensure Disaster Preparedness of DPWH Field Offices in Promptly Responding to Typhoons and Other Calamities Including Criteria in the Release of Calamity Funds”.

Also, secondary data from the Roads and Bridges Inventory and Assessment were utilized to determine the existing condition and performance of infrastructures to reinforce the result of the vulnerability assessments.

The questionnaire was reviewed and validated by individuals who have wide knowledge and expertise on the research topic. After the validation, all suggestions were incorporated and some of the items were improved. The try-out of the questionnaires followed. These were tried-out to the design and maintenance engineers of the Isabela 3rd District Engineering Office in Cauayan City, Isabela, Philippines.

The try-out of the questionnaire was deemed necessary to reveal its defects that could be corrected before it was put into its final form and administered to the participants. The try-out had helped the researcherss to determine if the instrument was properly designed or not and to identify the questionnaire items which were not properly worded, sequenced, were ambiguous to the participants who might not have the same frame of reference with the researcherss. All suggestions were incorporated after the try-out, some items were improved such that the questionnaires were clear, hence, easy to understand and to answer.

Data Gathering Procedure

The researcherss secured permission to float the questionnaires from the highest DPWH official of the regional office and every district engineering office included in the study. Upon the approval of the request, the researcherss sought the assistance of the division chiefs and section chiefs, and the technical professionals. At the same time, the researcherss explained the purpose and importance of the study and the possible benefits they would derive from the results of the study.

The research proposal was reviewed and approved by St. Paul University Philippines Institutional Ethics Review Committee; a committee whose task is to make sure that research participants are protected from harm. The participants were not forced to participate; rather, informed consent was sought. A letter was used to ask for the consent of the participants. The identity of the participants and their responses were ensured with utmost confidentiality.

Data Analysis

For the purpose of the study, the following statistical tools were used:

1. Frequency and Percentage. These were used to interpret the demographic profile of the participants.

2. Weighted Mean. This was used to determine the degree of vulnerability of infrastructures to climate change. The following scale was used to interpret the computed means:

To determine the degree of vulnerability of existing infrastructures to climate change, the following scales were also used for the three (3) vulnerability indicators:

Vulnerability Indicator: EXPOSURE		
Range	Exposure Level	Descriptive Interpretation
1.00 – 1.79	None	No exposure now and/or in the future
1.80 – 2.59	Low	Low exposure now and/or in the future
2.60 – 3.39	Moderate	Moderate exposure now and/or in the future
3.40 – 4.19	High	High exposure now and/or in the future
4.20 – 5.00	Very High	Very high exposure now and/or in the future
Vulnerability Indicator: SENSITIVITY		
Scale	Sensitivity Level	Descriptive Interpretation
1.00 – 1.79	None	No infrastructure service disruption or damage
1.80 – 2.59	Low	Minimal infrastructure service disruption and damage
2.60 – 3.39	Moderate	Localized infrastructure service disruption. No permanent damage. Some minor restoration work required
3.40 – 4.19	High	Widespread infrastructure damage and service disruption requiring moderate repairs.
4.20 – 5.00	Very High	Permanent or extensive damage requiring extensive damage

Vulnerability Indicator: ADAPTIVE CAPACITY		
Scale	Adaptive Capacity Level	Descriptive Interpretation
1.00 – 1.79	None	No capability to repair/restore
1.80 – 2.59	Low	Low capability to repair/restore
2.60 – 3.39	Moderate	Partial capability to repair/restore
3.40 – 4.19	High	High capability to repair/restore
4.20 – 5.00	Very High	Very high capability to repair/restore

Table 1. *List of Road Sections Included in the Vulnerability Assessment*

ROAD SECTION	District Engineering Office
Cagayan Valley Road	Cagayan 1st
Jct. Logac-Magapit Road	
Magapit Interchange Road	
Baybayog-Baggao-Dalin-Sta Maria Road	
Bangag-Magapit Road	Cagayan 2nd
Manila North Road	
Cadcadir-Kabugao Road	
Cagayan Valley Road	Cagayan 3rd
Cagayan-Apayao Road (Tuguegarao Section)	
Kalinga-Cagayan Road (Calanan-Enrile Section)	
Santiago-Tuguegarao Road	
Peñablanca-Callao Caves Road	
Daang Maharlika	Isabela 1st
Santiago-Tuguegarao Road	
Ilagan-Bigao-Palanan Road	

Road Section	Engineering District
Daang Maharlika	Isabela 2nd
Santiago-Tuguegarao Road	
Naguilian-San Mariano Road	
Daang Maharlika	Isabela 4th
Santiago-Tuguegarao Road	
Jct. Ipil-Quirino Boundary Road	
Daang Maharlika	Nueva Vizcaya 1st
Bambang-Kasibu-Solano Road	
Daang Maharlika	Nueva Vizcaya 2nd
Nueva Vizcaya-Pangasinan Road	
Cordon-Aurora Boundary Road (Jct. Dumabato-Aurora Boundary)	Quirino
Jct. Victoria-Alicia-Kasibu Road	

Table 1 shows the list of road sections in Region 02 that were included in the vulnerability assessment.

3. Analysis of Variance. This was used to determine the significant difference in the degree of vulnerability of infrastructures to climate change when grouped according to types of infrastructures. The hypothesis was tested at 0.05 level of significance.

III. RESULTS AND DISCUSSIONS

Profile of Infrastructures

Type of Infrastructure

Table 2. Frequency and Percentage Distribution of Infrastructures When Grouped According to its Type

Type of Infrastructures	Frequency	Percentage
Roads	28	9.93
Drainages	28	9.93
Bridges	226	80.14
Total	282	100.00

Table 2 shows the frequency and percentage distribution of infrastructures when grouped according to its type. The data show as indicated by the highest frequency of 226 or 80.15% that majority of the type of infrastructures being assessed were bridges, 28 or 9.93% were roads and drainages, respectively. It should be noted that the 28 primary national road sections in Region 02 are linked by plenty of bridges.

Years of Existence

Table 3. Frequency and Percentage Distribution of Infrastructures When Grouped According to Years of Existence

Years of Existence	Roads		Drainages		Bridges		Overall Total	
	f	%	f	%	f	%	f	%
1 to 10 years	10	3.50	10	3.50	27	9.6	47	16.70
11 to 20 years	15	5.30	15	5.30	79	28.00	109	38.70
21 to 30 years	2	0.70	2	0.70	35	12.40	39	13.80
31 to 40 years	1	0.40	1	0.40	26	9.20	28	9.90
41 to 50 years	0	0.00	0	0.00	49	17.40	49	17.40
51 to 60 years	0	0.00	0	0.00	7	2.5	7	2.50
61 years & above	0	0.00	0	0.00	3	1.1	3	1.1
Overall Total	28	9.90	28	9.90	226	80.10	282	100

Table 3 shows the frequency and percentage distribution of infrastructures when grouped according to years of existence. The data show as indicated by the highest frequency of 109 or 38.70% are infrastructures with 11 to 20 years of existence, 49 or 17.40% are infrastructures with 41 to 50 years existence, 47 or 16.70% are infrastructures aged 1 to 10 years, 39 or 13.80% aged 21 to 30 years, 28 or 9.90% aged 31 to 40 years, 7 or 2.50% aged 51 to 60 years, and 3 0r 1.1% are infrastructures with more than 60 years of existence. It also shows that according to type, many of infrastructures fall under the range of 11 to 20 years of existence.

It can be gleaned from the data that bridges have the longest year of existence. The DGCS [12] stated that the design life of bridges in the Philippines is taken as 50 years, 20 years for concrete roads, and 10 years for asphalt roads. Design life is the period assumed in the design for which the infrastructure is required to perform its function without replacement or major structural repair. However, the period of time that infrastructures are expected to be in operation will depend on the exposure conditions of structure; quality of materials, design, and construction; and the level of maintenance performed.

Degree of Vulnerability of Infrastructures to Climate Change

Table 4. Mean Distribution of the Infrastructures' Vulnerability in terms of their Exposure, Sensitivity and Adaptive Capacity to Climate Change

Area	Type of Infrastructure	Mean	Level of Vulnerability
Exposure	Road	3.21	Moderate
	Drainage	3.34	Moderate
	Bridge	3.15	Moderate
Sensitivity	Road	3.18	Moderate
	Drainage	3.11	Moderate
	Bridge	2.84	Moderate
Adaptive Capacity	Road	3.36	Moderate
	Drainage	3.36	Moderate
	Bridge	3.15	Moderate
Category Mean		3.19	Moderate

Table 4 shows the mean distribution of the exposure, sensitivity, and adaptive capacity of infrastructures to climate change. As seen on the table, all road infrastructures are rated "moderate" with a category mean of 3.19. This means that the road networks have a moderate exposure to different climate change effects and impacts now and/or in the future based on the exposure indicators used that include exposure to drought/extreme heat, storm/extreme rainfall, flooding and soil movements like landslide and erosion. Similarly, the moderate sensitivity of the infrastructures means that infrastructures experienced localized service disruption with no permanent damages but with some minor works required as these infrastructures were exposed and are affected by the changing climate. The participants claimed, however, that their district engineering offices have only partial capability to repair or restore the highway infrastructure system after a possible disruption or damages especially the permanent and extensive ones. With this, it can be interpreted that climate change makes the physical infrastructures vulnerable to its impacts. Some of the experienced impacts include asset destructions, road closures, travel time delay and inconvenience.

It can also be gleaned in the data that drainages are most exposed to climate stresses. This is due to the exposure of drainage system to extreme rainfall that results to flooding. Roads are most sensitive to climate change impact because these provide vital transportation links. The destruction of the road component of the transportation network would hamper mobility and convenience of transport. According to adaptive capacity, bridges are rated the lowest because planning, design, construction, maintenance, and reconstruction of these structures entail high technical expertise which is one of the barriers experienced by the district engineering offices. Also, the "moderate extent" rating for bridges is attributed to their years of existence since most of them have not yet reached their service life.

Based on the result of the latest Roads and Bridges Inventory and Assessment (RBIA) on the existing infrastructures under study, 114.044 kilometers or 15.49% or the road is rated as "bad", 203.55 kilometers or 27.65% is rated as "poor", 240.478 kilometers or 32.66% is rated as "fair", and 178.172 kilometers or 24.20% is rated as "good". On the other hand, 39.64% of the existing bridges subjects of vulnerability assessment are rated "good", 47.30% are rated "fair', 11.71% are rated "poor" and 1.35% are rated "bad". Taking into consideration that majority of the roads and bridges are rated "fair and good", this result of the RBIA supports the findings of the vulnerability assessment that these infrastructures are moderately sensitive when structural integrity is set as the indicator of the assessment.

The choice of the types of infrastructures involved in vulnerability assessment is supported by the findings of Fakhruddin [13] that land transportation is the most vulnerable infrastructure sector based on damaged assessment. High exposure of roads and bridges and their associated damage costs are the prime reason behind such high vulnerability ranking.

Birkmann, et al. [14] provide criteria to judge whether vulnerability is characterized as key risks. First, exposure is an important precondition for considering a specific vulnerability. He claims that if a system is not at present nor in the future exposed to hazardous climatic trends or events, its vulnerability to such hazards is not relevant in the current context. Second, the importance of the vulnerable system is key for the judgment; however, the identification of key vulnerabilities is less subjective when it involves characteristics that are crucial for the survival of societies or communities. This may include the interdependency of transport network to other societal infrastructures. Third is the limited ability of society, community, or professional groups to cope with and to build adaptive capacities to reduce or limit the adverse consequences of climate-related hazards. Coping and adaptive capacities are part of the formula that determines vulnerability. Lastly, vulnerabilities are considered key when they are persistent and difficult to alter. This is particularly the case when the susceptibility is high and coping and adaptive capacities are very low due to conditions that are hard to change.

Test for Significant Difference in the Degree of Vulnerability of Infrastructures to Climate Change when Grouped According to Type of Infrastructure

Table 5. Analysis of Variance on the Test for Significant Difference in the Degree of Vulnerability of Infrastructures to Climate Change when Grouped According to Type of Infrastructure

Area	Type of Infrastructure	Mean	Std. Deviation	F-Ratio	P-value	Remarks
Exposure	Road	3.21	0.65516	1.342	0.263	Not Significant
	Drainage	3.34	0.60940			
	Bridge	3.15	0.56630			
Sensitivity	Road	3.18	0.77237	2.952	0.054	Not Significant
	Drainage	3.11	0.83174			
	Bridge	2.84	0.85105			
Adaptive Capacity	Road	3.36	0.95119	1.127	0.326	Not Significant
	Drainage	3.36	0.91142			
	Bridge	3.15	0.94055			

Table 5 shows the analysis of variance on the test for significant difference in the degree of vulnerability of infrastructures to climate change when grouped according to type of infrastructure. The computed probability values are all greater than 0.05 level of significance. This means that the null hypothesis is accepted. The table further implies that there is no significant difference in the degree of vulnerability of infrastructures to climate change when grouped according to their type. This only means that the performance of the three types of infrastructures in terms of their vulnerability does not differ significantly.

Proposed Activities that can be Implemented to Enhance the Climate Change Adaptation of DPWH Region 02 Philippines

Rationale

Climate change is one of the most serious problems the world is facing nowadays. The drastic changes of normal climate patterns have affected the natural environment and have cascaded to resources and assets that support mankind. These led to the formulation of policies and programs for climate change adaptation.

Climate change adaptation programs are essential to ensure that all sectors of the community are able to cope and respond to the impact of climate changes. These programs strengthen the adaptive capacity of humanity against extreme episodic disasters and chronic hazards brought by climate change events. In the infrastructure sector, climate change adaptation is essential to ensure that infrastructures are climate resilient. This will avoid the domino-effect on socio-economic stability of the community.

Proposed Activities:

- Conduct of orientation and cascading of standards and policies related to CCA
- Conduct of trainings and seminars
- Provision of scholarships through linkages with other agencies and send technical professionals to trainings
- Provision of additional technical professionals including allocation of one geologist for each office (DEO)
- Inclusion in the National Budget funds for CCA especially for disaster response and restoration of damages brought by climate-induced disasters
- Enrich the emergency response plan to include specific disasters brought by climate change
- Integrate Climate Change Adaptation (CCA) as part of the functions of planning and design division and maintenance division

IV. CONCLUSION

One of the important contributions of the Department of Public Works and Highways in the realization of the overall resiliency of the country to climate change is the provision and formulation of standards, guidelines, and policies on climate change adaptation. The department also considers asset management of existing infrastructures as a strategy to build resilience by ensuring that road networks are always operational. In this study, the level of awareness of professionals involved in undertaking the mandated services of the department is very essential for climate change adaptation. Their capacity and ability to respond to climate impacts on infrastructure can be best attributed on their level of knowledge on climate change issues as well as their level of expertise in carrying out the design, operation, and maintenance work adaptable with the changing climate conditions. Similarly, compliance and extent of implementation also affect the performance of the agency on adaptation. The higher compliance and implementation mean higher adaptation performance.

On the other hand, the moderate vulnerability of infrastructures being assessed implies that climate change is already experienced by these infrastructure systems. In Region 02, the prominent climate stressors like extreme rainfall, typhoons, and droughts as well as their adverse impact is already affecting the resiliency of built environment.

The DPWH agency is putting effort to adapt with climate change; however, there are various barriers and challenges that hinder effective adaptation. The insufficiency and availability of funds to construct climate proof structures, upgrade of existing structures and even in the restoration and reconstruction of damaged infrastructures are experienced to by the participants to a great extent. The lack of training programs to enhance the technical expertise of professionals limits their adaptive capacity to climate impact. The low-level expertise hampers their effective engineering decisions toward climate change adaptation. There is also a lack of a complete program that would oversee climate change resources requirements, planning, implementation, monitoring and evaluation.

The planning capacity of the agency on climate change adaptation is high; however, the barriers and challenges experienced by the technical professionals hamper the effective implementation of the plans and programs of the agency.

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